A Field Survey-Based Study of Household Energy-Use Patterns in Tertiary Institutions Communities in Imo State

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ABSTRACT

The availability of energy sources, particularly electricity, is a basic requirement for living standards. The efficiency with which households use energy is critical not just for improving individual living conditions, but also for a country's economic growth. There is a considerable imbalance between electricity demand and generation in Nigeria. The purpose of this survey is to investigate the energy-related perceptions and awareness of household consumers in Ihiagwa and Nekede communities, and, to determine the level of alignment of this awareness with their actual preferences and behavior to derive insights for environmental and energy policy planning and management. We have collected the data in the form of questionnaires related, to personal profiles, behavior, and attitudes in the use of energy and electricity in 676 households in Nekede and Iheagwa. By analyzing the data, it was found that the Households (82.0%) prefer electricity to other forms of energy. A large percentage of people (67.1%) believed that their electric bill was causing them financial difficulties, and 80.2% had made efforts to reduce their electricity bill. Furthermore, the results suggest an attitude-behavior gap in terms of energy sources and purpose of usage. Commercial energy is used and petroleum sources come as a stand-in alternative source. The household features and average energy cost was correlated. The results show that ownership of the building factor had a statistically insignificant coefficient, a p-value of 0.5586, income relationship with energy cost was a significant factor p-value of 0.0009, and the number of family members and energy cost had a p-value of 0.0004 respectively. The findings of this survey should be useful for future planning of household energy management in Imo State and Nigeria by extension. These would aid in the development of the national energy strategy plan, as well as in understanding current energy use and availability conditions.

1. INTRODUCTION

With population growth, residential energy consumption in Nigeria is increasing due to rapid urbanization and growing income levels, and demand has grown rapidly, with an annual increase and rapid population growth rate (Olowolafe et al., 2023). The growth in demand for electricity, in particular, is even higher, with an annual average growth rate of 12.35 percent (NBS, 2018). This quick increase corresponds to the rapid growth of important durable consumer items such as air conditioners, laptops, shower heaters, and microwave ovens. Soon, with the population expected to live within and around urban areas (tertiary institutions communities), residential

energy consumption is likely to continue its rapid growth (Onime, 2019; Ekoh and Ejimkaraonye, 2020). On the one hand, high energy consumption represents an improvement in people's quality of life and the nation's degree of development (Liu et al., 2015). On the other hand, it may burden further Nigeria's efforts toward energy generation, distribution, and even gas emissions abatement. As part of the global low-carbon emission plan. Therefore, decision-makers and the public need to understand the patterns, determinants, and implications of households' demand for energy and its consequences on the turbulent national energy

needs. Scholars and government organizations in many industrialized and developing nations conduct surveys of home residential energy regularly, and they have become a major source of energy data (Zheng et al., 2014; Vega et al., 2022; Akeh et al., 2023). In most advanced countries surveying households' energy use, and various informative studies have been undertaken as a result (Sanquist et al., 2012; Belaïd, 2016; Xu and Chen, 2019).

A similar survey, however, does not exist in Nigeria. Currently, the literature and national statistics provide only fragmentary information regarding household energy. Yohanna et al (2013) investigated the energy consumption end use of some selected residential buildings in Kaduna and Kano in the Northern part of Nigeria by comparing their energy consumption pattern, the energy usage and intensities of the buildings and when retrofitted with green features to document the impact of the green retrofits. Ogwumike et al. (2014) analyzed Nigerian home energy use and its variables using data from the 2004 Nigeria Living Standard Survey collected from the National Bureau of Statistics. Their study utilized descriptive statistics and multinomial logit models. They discovered that the majority of Nigerian homes use firewood for cooking and kerosene for lighting. This demonstrates that the majority of Nigerian homes do not have appropriate access to ecologically acceptable modern energy sources. Olaniyan et al. (2018) researched the use of combined household-reported data on electrical equipment ownership and energy spending to estimate current and future home electricity demand in Nigeria, as well as the required generation capacity to ensure complete electricity access under various scenarios. Adamu et al. (2020) analyzed various energy sources for household consumption and discusses the ramifications of their reliance on traditional energy sources. They contend that most Nigerian households' reliance on energy sources at the bottom of the energy ladder is exacerbated by rising poverty levels, which is consistent with the energy ladder hypothesis, but they disagree with the notion that most households use a combination of energy sources for their activities.

Emagbetere et al. (2016) explored the factors influencing the choice of household energy used for cooking and the type favored in the Ikeja district of Lagos state. According to their findings, kerosene and liquefied petroleum gas (LPG) were the most commonly used fuels. Only a small percentage of people cook with charcoal, firewood, or electricity daily. While all of these local studies focus on residential home energy use, they fail to capture consumer behaviors, perceptions, and attitudes toward energy use. To fill this gap, we developed an

Energy Usage Assessment Questionnaire (EUAQ) and used it in Nekede and Iheagwa Communities in Owerri West Imo State Nigeria. It covers household demographics, electricity billing methods, resident behavior, attitude, and perception of the national energy outlook.

The survey makes important contributions. One of which is an attempt to develop a complete survey and provide an overview of residential energy consumption in tertiary institutions communities. The suggestion from the survey will inform policymakers and the public about changes in energy usage patterns in this semi-urban area and a perspective on future leaders' environments. This also will help to develop more credible projections of energy demand through a better understanding of crucial determinants, such as significant changes in years lived within a location feature and household income growth. Again, our study would provide the landmark and the basis for evaluating the effectiveness of various efforts to promote energy efficiency. The full data allows us to investigate the extent to which households participate in energy efficiency programs, as well as their attitudes and behavior in practice at the local level. Lastly, this survey is an important database for evaluating residential energy conservation concepts.

This survey aims to introduce the concept and benefits of energy efficiency usage in buildings and homes. Other objectives of the study are: First, to establish what is known about energy efficiency standards at the national, state, and local levels. Second, to obtain reliable data on energy consumption, and household expenditure features. Third, to determine the energy intensity (how much energy households consume, per disposable income) measurements. Fourth, to determine energy efficiency measurements in the sample area.

2. METHODOLOGY
2.1. Survey description
Between July and August 2022, the survey was administered. A few guides including the harmonized survey questions for tracking household energy usage and SDG indicators 7.1.1 and 7.1.2 were used to create the questionnaire (WHO, 2019). The questionnaire comprised 52 questions covering household demographics, dwelling characteristics, space heating and cooling, patterns and behavior of electricity use, and electricity billing methods. Higher National Diploma (HND) and Ordinary National Diploma (OND) students 60 in number from Federal Polytechnic Nekede Owerri were recruited as ad-hoc workers to administer the questionnaire, and data entry into the computer. To guarantee the survey quality, all interviewers were given intensive training

before deploying them to the field. During the fieldwork, they were supervised by experienced survey workers. Each interviewer used a smartphone or handheld GPS receiver to collect the locations of the surveyed households. Households that met predetermined criteria were administered the questionnaire. Households that fell short of the criteria were removed during the data-cleaning stage. The survey field workers were all enumerated and each interviewed participant was also given a Global System for Mobile (GSM) communication prepaid card of 100 Naira as incentives. A total of 700 households were interviewed during the survey, and 676 household data was taken as the sample size after data cleaning amounting to a successful sample rate of 96.57%.

2.2. Survey Data Description

Based on previous studies (Olaniyan et al. 2018; Adamu et al. 2020; Dinesh et al, 2020; Zhang et al. 2021; Agarwal et al., 2023; Azimi et al. 2023; Çebi and Algül, 2023) and the purpose of this research, several questions about the respondent's specific attitudes towards residential energy use and associated behaviors were asked in the survey. Socio-demographic variables, building ownership, and energy outlook perception of respondents were also surveyed as shown in Table 1. Respondents' energy

consumption response on personal finances, was also surveyed to help understand the attitude-behavior relationship (Table 1). Specifically, attitude-related questions were 22 in number which include 'Are energy efficiency and conservation not that important to you', their concerns with energy usage, 'Whether they take actions to conserve energy, and whether they pay attention to energy efficiency parameters/indicators when purchasing electronic devices'. Based on our classification of occupant behavior in residential buildings, the energy-related behaviors important to this research are the effect of energy cost on the occupant and their behavior relating to residential energy use. The correlations between energy cost and household attributes were also investigated.

2.3. Statistical methods

Given the types of data involved, correlation analysis, Chi-square, and Cramer's tests were employed to examine the relationship between energy cost and household attributes concerning residential energy use in Owerri West. Regression was used to further identify the factors influencing occupants' relevant attitudes. Liu et al., (2015) and Zhang et al. (2021) used the regression method for modeling a binary dependent variable which lends itself well to the research of occupants.

Table 1: Profile of household characteristics

Category	Variable
Personal Profile of household characteristics	How long lived at this location
	Average monthly Income
	Household size
	Are you a tenant or owner
	who pays for your electricity bills
	How do you provide warmth/cool to your home
	average monthly energy cost
	Have you or your landlord taken steps to lower your energy bills
	How are you billed for your monthly electricity use

Table 2: Questions on the resident's energy use behavior and perceptions.

Category	Variable
Behaviors	Do you unplug electronic devices that are not being used?
	Do you shop for electrical products that are more energy efficient?
	Do you turn off all lights before leaving a room?
	Do you encourage friends or family to turn off electronic devices that are not being used?
	Do you use energy-efficient bulbs?
	Do you unplug electronic devices that are not being used?
Individual perception	Your electricity bills are causing you financial hardship.
	The actions you take at home are affecting your electricity bills.
	You have made an effort to reduce your electricity bill.
	You encourage friends or family to be more energy efficient.

3. RESULTS AND DISCUSSION

3.1. Profile of the Residents

The study revealed that most households surveyed had 4 to 6 inhabitants as shown in Figure 1a, and Figure 1b depicted the number of years the respondents lived in that location. At the time of the study, the typical surveyed household had been in their current residence for more than ten years. The majority of the inhabitants indicated they were tenants and paid the electric bill themselves. Electricity was the favored form of energy used by the residents. The survey also revealed that most residents spent more than twelve thousand Naira on energy monthly. The respondents revealed also that the landlords had taken steps to improve energy efficiency and lower energy bills (Figure 1c), for instance by replacing filament bulbs with LED bulbs, use of induction over electric coil cooktops, replacing more energy-consuming and electronic gadgets with less energy efficient ones.
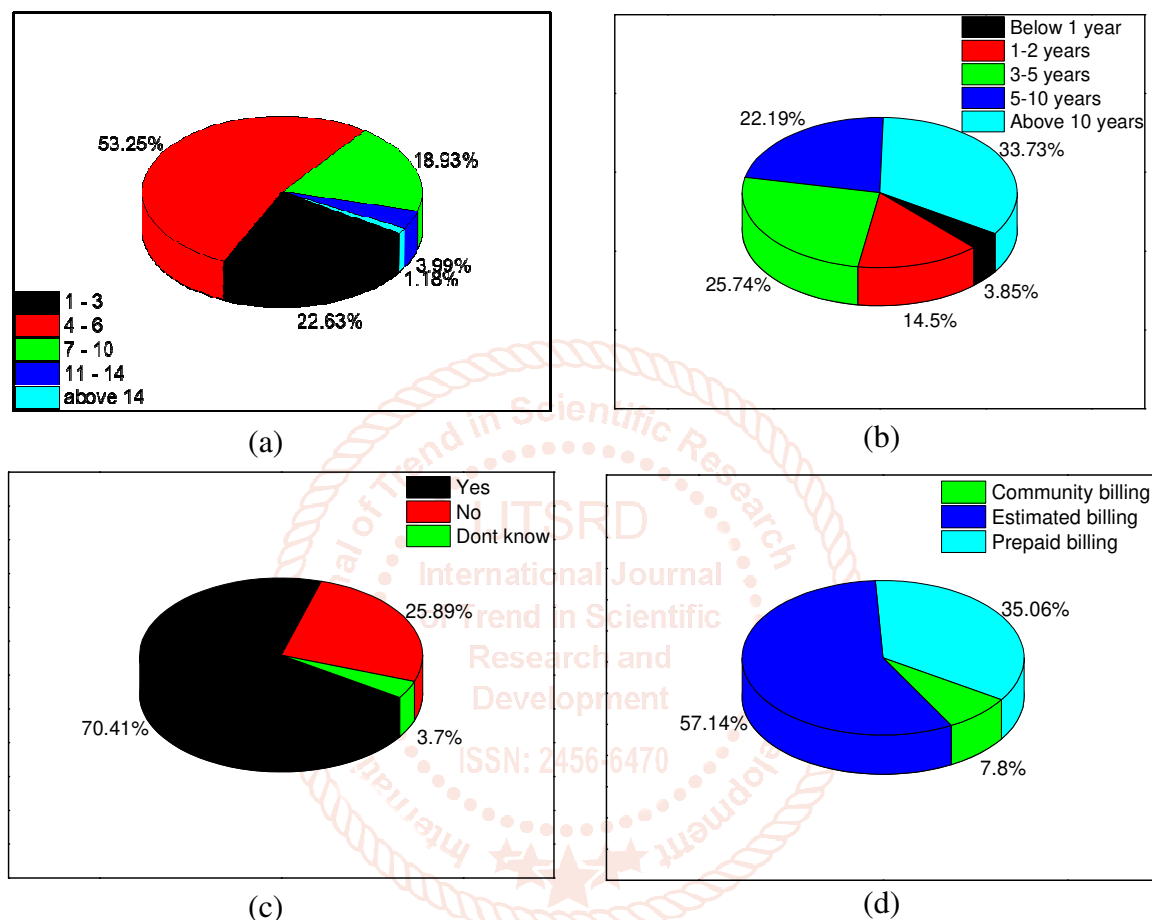

Figure 1: Profile of the respondents (a) number of people in the household, (b) the number of years lived in the building, (c) landlord and I had taken steps to improve energy efficiency, and (d) how respondents' was billed for electricity use.

3.2. Occupants' energy awareness and Actions

In general, respondents had an energy-saving mindset toward power in residential buildings. They showed a strong desire to cut domestic energy consumption. A large number of respondents 475 (70.4%) of the respondents agree that they and their landlords had taken steps to improve energy efficiency and lower their electricity bills. Similarly, 552 (81.7%) of the respondent agreed that they encouraged friends or family to be more energy efficient. The respondents' awareness and habitual behaviors are shown in Figure 2 and Figure 3, respectively. Their awareness was represented by responses to if the electricity bills are causing financial hardship, if their actions affect electricity bills, if they had made an effort to reduce electricity bills, and if they encouraged friends/family to be more energy efficient. The results suggested they were more energy efficient aware than the average level on the market.
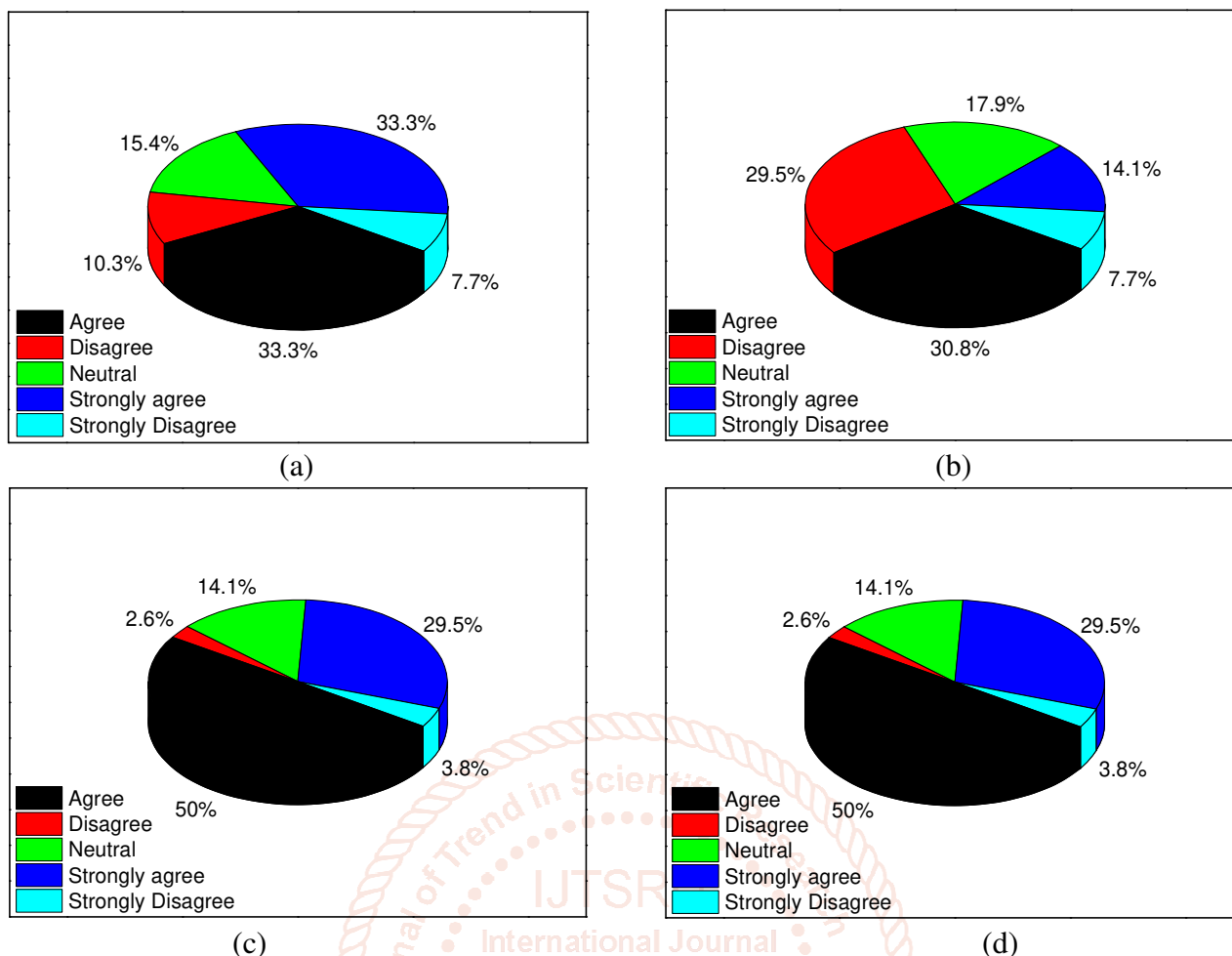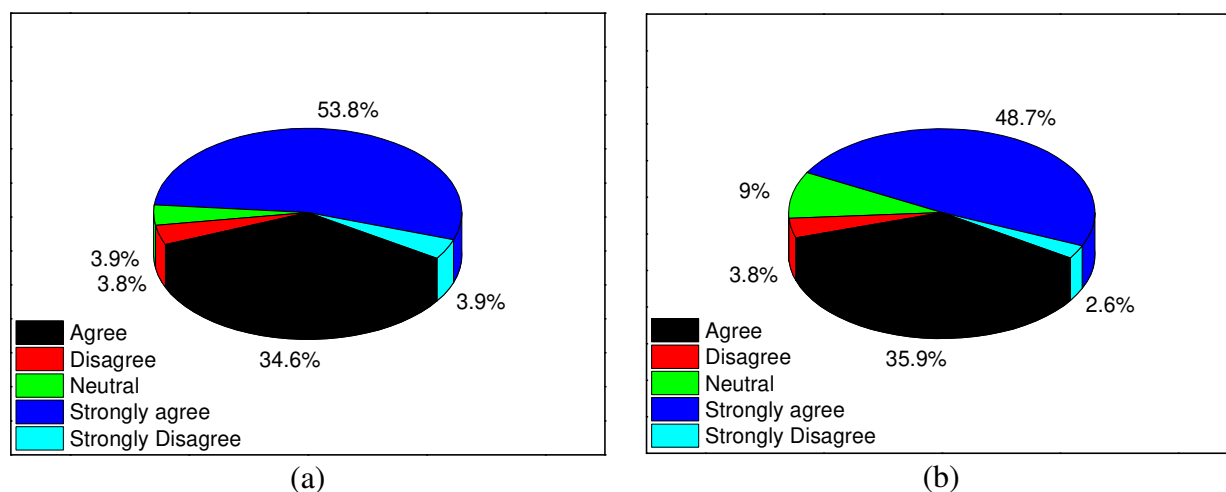
(a)

(b)

(c)

(d)

Figure 2: Awareness of the respondents (a) Electricity bills are causing financial hardship, (b) My actions affect electricity bills, (c) My actions affect electricity bills, and (d) Encourage friends/family to be more energy efficient.

A similar pattern emerged in their habitual reaction to domestic appliances and lighting - the majority behaved in a way that indicated reducing and avoiding excessive energy use in their homes. In all, as shown in Figure 3a, 53.8% (371) of the respondents strongly agreed to unplug electronic devices that are not being used; when shopping for electrical products, 48.7% (335) considered devices that are more energy efficient; another 53.7% turned off all lights before leaving a room that was 364 of the sampled population; and 407 used energy-efficient bulbs (i.e. 60% of the sample population). In addition, 228 (33.7%) strongly agreed that their electric bills were causing them financial difficulty. The study further revealed that about 44.2% encouraged family, friends, and neighbors to be more energy efficient.
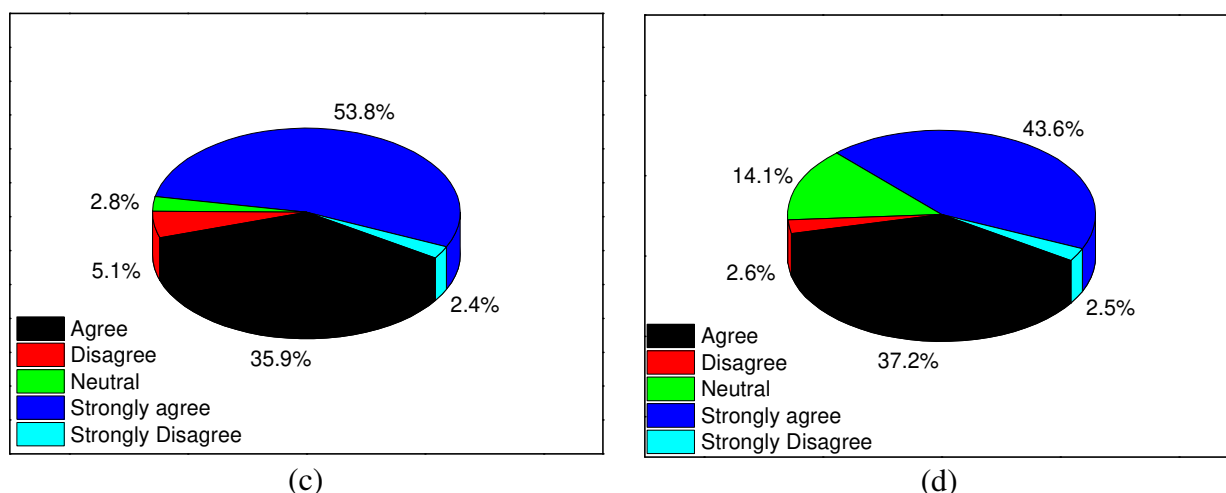

(a)

(b)

(c)

(d)

Figure 3: Attitude of the respondents (a) Electricity bills are causing financial hardship, (b) My actions affect electricity bills, (c) My actions affect electricity bills, and (d) Encourage friends/family to be more energy efficient

3.3. Respondents' Position of energy demand/use

The percentage of the future energy demand by the dwellers is shown in Table 3, cumulatively households viewed that the use of oil as an energy source would increase to a value of 44.7%, while those that would opt for gas as an energy source would increase by 69.6%, and the use of coal as an energy source would go up by 27.7%. Consumption of renewable energy sources was predicted to rise by 80.3%. The likely change in consumer energy awareness, energy demand, and energy usage expenses were all expected to be high with the respondents projecting significant increases to 35.8, 52.5, and 41.2% respectively. This depicted a significant increase in expectations by the dwellers for the production and distribution of all sources of energy from the government and its agencies. Inquiring from the dwellers how they kept themselves warm or cool, was to get their most preferred and readily available sources of energy used. Their reply revealed that respondents utilized electricity the most. Electricity is the most preferred 82.0% and it was the respondent's most accessible form of energy being utilized in the locality. Irrespective of their preferred energy source, 226 agreed and 228 significantly agreed that their electricity bills were causing them difficulties. This exposed heavy reliance on the public grid (82.0%) by the population as an energy source irrespective of its financial challenge on their income.

Table 3: Anticipated energy demand by dwellers of Nekede and Ihiagwa Communities.

|	Significantly increase	Increase	No change	Decrease	Significantly decrease
Use of oil as an energy source	10.5	34.2	35.4	15.9	4.0
Use of gas as an energy source	25.2	44.4	25.0	2.7	2.7
Use of coal as an energy source	10.6	17.1	35.2	19.5	17.5
Renewable energy consumption	34.6	45.7	18.3	1.3	0.0
Consumer energy awareness	35.8	41.6	18.5	4.1	0.0
Energy demand	52.5	40.9	5.2	0.0	1.3
Energy consumption costs	41.2	36.0	6.8	13.2	2.7

3.4. Energy Used and energy demand to Income

The frequency distribution table of the average monthly energy cost is shown in Table 4 and the percentage distribution is shown in Figure 3. The majority of people with high monthly costs had high incomes, as shown in Table 4, and the next group of people with a high monthly energy expense had incomes between NGN200,000 and NGN300,000. Similarly, Figure 3a revealed that only 5.2% of respondents paid little monthly energy bills (below NGN3,000). About 46.9% of respondents had a rather high monthly energy bill (above NGN12,000). Almost 23.1% of respondents had an average monthly bill between N9,000 to NGN12,000 It is thus deduced that people in the considered area are more likely large households with six or more people per household as learned in Figure 1a. The distribution of Household Incomes is shown in Figure 3b. Figure (3b) revealed that 9.0% of respondents earned below the national minimum monthly income (NGN30,000). Meaning that the underemployed residents in the survey population were few.

Table 4: Frequency distribution of the average monthly energy income and cost

Income range	Frequency	Monthly cost	Frequency
Below 30,000	61	Below 3,000	35
30,001 - 100,000	147	3,001 - 6,000	97
100,001 - 200,000	258	6,001 - 9,000	71
200,001 - 300,000	131	9,001 - 12,000	156
Above 300,000	79	Above 12,000	317

As clearly shown in Table 4, 21.8% of respondents earned between NGN30,000 to NGN100,000. According to the survey, 38.2% of respondents were average income earners (100,000 to 200,000 Naira per month) in agreement with a report by Emagbetere et al., (2016). Furthermore, 11.7% were high-income earners (over NGN300,000). It is therefore inferred that individuals in the surveyed population are more likely to be average monthly income earners while people in the area considered are improbable to be zero income earners.
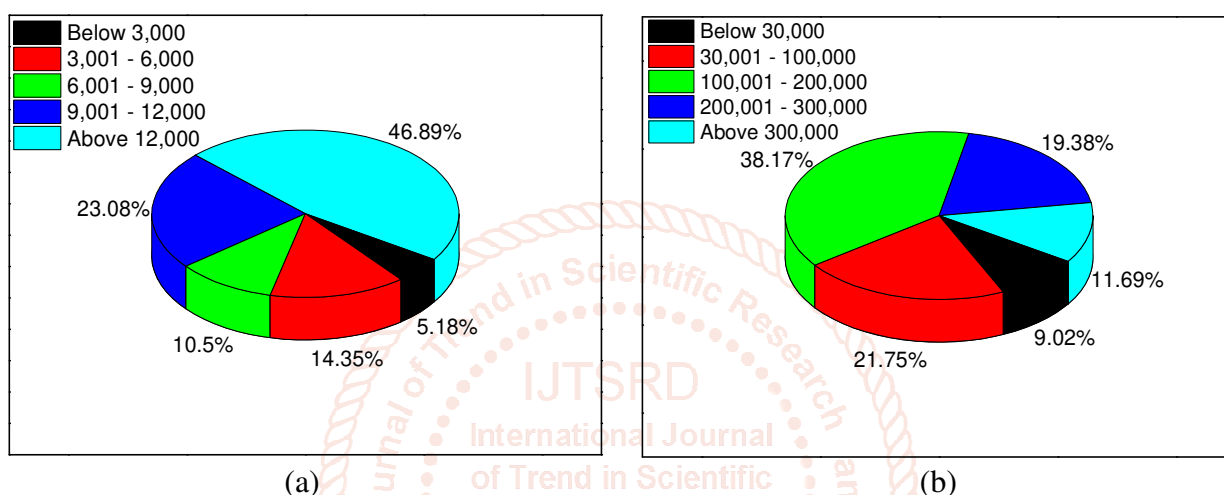
Figure 3: Percentage distribution of the average energy used and monthly income

3.5. Household features and average energy cost

The results in Table 5 depict the relationship between descriptive variables and years lived in the households by employing the Pearson Chi-square model. The first treatment of Chi-square, which examines the ownership of the building factor, shows a statistically insignificant coefficient ($\chi^2 = 2.98$, p-value = 0.5586). This study intimates that the ownership differences do not influence the average energy cost of the household. Secondly, the results of the Chi-square for the years lived in the location factors are significant ($\chi^2 = 26.87$, p-value = 0.0422), indicating the importance of years lived within the neighborhood as an influencing factor. Understandably, new residents prefer energy sources from the mains, whereas older neighbors have more ideas for alternative sources. Income is one of the most crucial factors in making any decision, especially in rural communities in developing countries (Li et al., 2019; Sievert and Steinbuks, 2020; Son and Yoon, 2020; Zi et al., 2021), since these communities are not financially well-off when compared to most more urbanized communities in Nigeria (Arhin-Sam, 2019; Nwalusi et al., 2022). The relationship between the number of family members and energy cost was statistically significant ($\chi^2 = 78.70$, p-value = 0.0004). It is a common belief that the need for electricity and energy usage increases with an increase in the number of people in the household. Our results corroborate the findings of other relevant studies (Louw et al., 2008; Nnaji et al., 2012; Ogwumike et al., 2014; Wassie et al., 2021). In our study, income was also a significant factor ($\chi^2 = 91.44$, p-value = 0.0009). Our findings exhibit that wealthier households had a higher energy bill, we also found that few wealthy households use different mixtures of energy sources. Conversely, households with low monthly incomes preferred to use cheaper energy sources. Overall, an increase in income level reduces the household's choice.

Table 5: Pearson's Chi-square (χ2) test of association between household characteristics and average energy cost per household.

Variable	Category	N (676)	χ2	p-Value	Cramer's V
Ownership of the building	Tenant	396	2.98	0.5586	–
	Landlord	280			
Years lived at the location (years)	Below 1	26	26.87	0.0422	0.1134
	1-2	98			
	3-5	174			
	5-10	150			
	Above 10	228			
Household family size	1–3	153	78.70	0.0004	0.2224
	4–6	360			
	7-10	128			
	11–14	27			
	Above 14	8			
Household average monthly income (Naira)	Below 30,000	61	91.44	0.0009	0.2082
	30,001 - 100,000	147			
	100,001 - 200,000	258			
	200,001 - 300,000	131			
	Above 300,000	79			

CONCLUSION

Based on a large-scale empirical survey in Nekede and Ihiagwa communities, the study showed that electricity is the most preferred form of energy used. It explored the attitude-behavior gap in residential energy use. Precisely, several energy-related attitudes were examined, including unplugging electronic devices that are not being used, considering more energy-efficient electrical products when shopping, turning off all lights on leaving a room, encouraging friends or family to be more energy efficient, using energy-efficient bulbs, to unplug electronic devices that are not being used. We established a mixed depiction concerning the attitude-behavior gap. When it comes to their habitual reaction to electricity use (warming or cooling their household), an attitude-behavior gap emerged residents don't necessarily shift away from the source of energy they claim was causing them financial difficulty. The results suggested the attitude-behavior flip-flop varied for different residents. It also showed that other than income, there was an intricate network of interrelated socio-economic factors that drive household energy evolution and the degree of the influence of those factors varied among communities. Our findings have two significant policy implications. First, there is a significant relationship between household income, household size, the number of years lived in a location, and the average monthly cost of the energy used, our investigation demonstrates an overall picture to help policymakers understand the current residential energy consumption pattern in the study area in terms of energy usage types and consumers activities. Second, our dataset provides a basis for evaluating the effectiveness of various energy policies, especially the electricity policy.

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